registration of the medical images using the one or more trained artificial agents and electronically transmits the registration results to the client computer, which then displays the registration results on a display of the client computer. The method steps to perform the registration in the network-based cloud-computing system can be performed by a single computer device in the network-based cloud-computing system (e.g., the server) or may be distributed on multiple computer devices or processors in the network-based cloud-computing system.

[0152] The foregoing Detailed Description is to be understood as being in every respect illustrative and exemplary, but not restrictive, and the scope of the invention disclosed herein is not to be determined from the Detailed Description, but rather from the claims as interpreted according to the full breadth permitted by the patent laws. It is to be understood that the embodiments shown and described herein are only illustrative of the principles of the present invention and that various modifications may be implemented by those skilled in the art without departing from the scope and spirit of the invention. Those skilled in the art could implement various other feature combinations without departing from the scope and spirit of the invention.

1. A method for deformable registration of medical images using an intelligent artificial agent, comprising:

receiving a first medical image and a second medical image;

calculating action-values for a plurality of actions based on a current state using a trained deep neural network, the current state determined from the first medical image and the second medical image;

selecting an action from the plurality of actions based on the calculated action-values;

computing a deformation field based on the selected action and a deformation model;

applying the deformation field to the first medical image to warp the first medical image; and

repeating the calculating, the selecting, the computing, and the applying for a plurality of iterations using the warped first medical image as the first medical image to register the first medical image and the second medical image.

2. The method of claim **1**, wherein calculating action-values for a plurality of actions based on a current state using a trained deep neural network comprises:

extracting features from the first medical image using first convolutional layers of the trained deep neural network;

extracting features from the second medical image using second convolutional layers of the trained deep neural network; and

comparing the extracted features from the first medical image and the extracted features from the second medical image to calculate the action-values for the plurality of actions.

3. The method of claim **2**, wherein the first convolutional layers and the second convolutional layers are implemented with separate weights.

4. The method of claim **1**, wherein computing a deformation field based on the selected action and a deformation model comprises:

encoding deformation for an entirety of the first medical image using a dense model.

5. The method of claim **4**, wherein applying the deformation field to the first medical image to warp the first medical image comprises:

decoding the deformation for the entirety of the first medical image; and

applying the decoded deformation to the first medical image.

6. The method of claim **1**, wherein computing a deformation field based on the selected action and a deformation model comprises:

encoding deformation at particular points in the first medical image that have corresponding points in the second medical image using a correspondence based model.

7. The method of claim **6**, wherein applying the deformation field to the first medical image to warp the first medical image comprises:

decoding the deformation at the particular points in the first medical image;

transforming a mesh of a segmented structure in the first medical image based on the decoded deformation;

computing a dense deformation field based on the transformation of the mesh; and

applying the computed dense deformation field to the first medical image.

8. The method of claim **1**, wherein computing a deformation field based on the selected action and a deformation model comprises:

modeling deformation of pixels at a location in the first medical image as having a Gaussian distribution; and

computing a deformation at a particular point in the first medical image based on a distance between the particular point and the location, a magnitude of the Gaussian distribution, and a standard deviation of the Gaussian distribution.

9. The method of claim **1**, wherein the trained deep neural network is trained to predict the action-values for the plurality of actions based on a plurality of training image pairs with known ground truth transformation parameters using reinforcement learning in which, for each training image pair, a reward for each action of the plurality of actions at a given state is used to train the deep neural network to learn an optimal registration policy.

10. An apparatus for deformable registration of medical images using an intelligent artificial agent, comprising:

means for receiving a first medical image and a second medical image;

means for calculating action-values for a plurality of actions based on a current state using a trained deep neural network, the current state determined from the first medical image and the second medical image;

means for selecting an action from the plurality of actions based on the calculated action-values;

means for computing a deformation field based on the selected action and a deformation model;

means for applying the deformation field to the first medical image to warp the first medical image; and

means for repeating the calculating, the selecting, the computing, and the applying for a plurality of iterations using the warped first medical image as the first medical image to register the first medical image and the second medical image.